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THE RELATIONSHIP BETWEEN DECLINING  
USE OF RURAL HOSPITALS AND ACCESS TO  
INPATIENT SERVICES FOR MEDICARE  
BENEFICIARIES IN RURAL AREAS

Technical Report  
#E-90-01

By  
Codman Research Group, Inc.

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January 1990

This report was prepared by Codman Research Group, Inc. under contract to the Prospective Payment Assessment Commission. The work described in this report has been monitored by ProPAC staff to ensure adherence to the contract's technical specifications. This work is not subject to Commissioner review and approval. Therefore, opinions, conclusions, and findings do not necessarily represent the views of the Commission. Comments about the report may be sent to ProPAC, 300 7th St. S.W., Washington, D.C. 20024.

The Relationship between Declining Use of Rural Hospitals and

Access to Inpatient Services for

Medicare Beneficiaries in Rural Areas

Report prepared by

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## EXECUTIVE SUMMARY

Financial problems and declining use of rural hospitals raise questions about whether access to inpatient services for Medicare beneficiaries living in rural areas is impaired. This study addresses this concern by focussing directly on the beneficiaries themselves. It examines their patterns and rates of hospital use between 1984 and 1986 in five states -- Alabama, California, Illinois, Montana, and Texas -- to try to answer the following questions:

- Are patterns of hospital utilization changing for Medicare beneficiaries living in rural areas? If so, how?
- How does the clinical mix of admissions differ between rural and urban Medicare beneficiaries and what are the implications for hospitals?
- What changes have occurred in the volume of admissions among different types of hospitals in rural areas? What is the impact of these changes on the per capita admission rates of Medicare beneficiaries?
- What factors explain the lower revenues in rural relative to urban hospitals?
- Is access to inpatient services impaired? If so, are any specific populations in rural areas particularly affected?

The study focuses on the hospital utilization patterns of geographically defined populations. It compares the utilization patterns of Medicare beneficiaries residing in rural areas with those in urban areas in the same states and with the national average for all Medicare admissions. Changes in utilization patterns during the study period are also identified. The study examines all inpatient services provided to Medicare beneficiaries age 65 or older in any acute care hospital, regardless of the location of the hospital providing services.

Medicare populations in rural areas are grouped into five types to determine whether specific circumstances, such as being served predominantly by an under 50 bed hospital, limits access to care. To test whether access is impaired for some services and not others, Diagnosis Related Groups (DRGs) are aggregated to case types based upon two criteria. The first is whether Medicare beneficiaries tend to use local or referral hospitals for the specific admission. The second is whether strong consensus exists among physicians on the need for hospitalization for treatment of the condition or whether a particular procedure is appropriate.

The major finding of this study is that:

- Access to care does not appear to have been impaired for Medicare beneficiaries who reside in rural areas in the five states.

In addition, the study found that:

- Hospital admission rates per capita were significantly higher for Medicare beneficiaries residing in rural areas than for beneficiaries in urban areas in 1984 and 1986.
- Hospital admission rates for Medicare beneficiaries in both urban and rural areas in all five states decreased between 1984 and 1986.
- Although the rate of decline in hospital admission rates per capita was greater for rural Medicare beneficiaries than for urban beneficiaries, rural admission rates remained significantly higher than urban rates in 1986.
- The largest decrease in Medicare admission rates occurred among high volume medical conditions for which there is relatively weak consensus on the need for hospitalization: pneumonia, congestive heart failure, transient ischemic attacks. This decrease occurred for both rural and urban beneficiaries but was greatest in rural areas. These medical conditions represented the largest component of rural hospitals' total admissions.
- Admission rates remained relatively constant for treatments and procedures where there is strong consensus on criteria for admission, as in hospitalization for hip fracture, heart attack (acute myocardial infarction) and hernia repair. Medicare beneficiaries' per capita admission rates for these treatment and procedures varied little from one area to another, with rural rates being slightly higher than urban ones.
- Admission rates for surgical procedures (excluding those with a strong outpatient site of treatment option) are nearly equivalent for urban and rural Medicare populations.
- The use of technology intensive treatments and procedures by rural beneficiaries increased relative to urban beneficiaries. These treatments and procedures generally are provided in rural referral centers and large urban hospitals, not the smallest hospitals.
- Medical conditions for which DRG payments are low make up a larger proportion of total admissions to small (<100 beds) rural hospitals than to rural referral centers or most urban hospitals. The small hospitals receive few of the dollars spent on surgery and technology-intensive care, and therefore receive less revenue.
- The hospital utilization patterns of Medicare beneficiaries in rural areas appear to be becoming more like those of urban beneficiaries both in terms of per capita admission rates and the mix of clinical services they receive.
- This study demonstrates that admission rates can be monitored routinely to evaluate the adequacy of access to hospital care for rural Medicare populations.

## INTRODUCTION

Utilization of hospitals has been declining for much of this decade for all Medicare beneficiaries, regardless of residence. Per capita admission rates among beneficiaries in rural areas historically have been high relative to those of Medicare beneficiaries living in urban and suburban areas. The decline in rural areas, however, has been greater. This study compares the admission rates of rural Medicare beneficiaries between 1984 and 1986 with those in urban areas to determine whether decreasing admission rates represent diminished access to inpatient services.

### Background

An atmosphere of crisis surrounds both political activity and media coverage of rural health care. In November 1988, the National Rural Health Association announced that it was suing the Department of Health and Human Services (DHHS) to challenge Medicare's lower payments for rural hospitals, contending that the lower rates are unconstitutional.<sup>1</sup> Newsweek's headline, "Don't Break a Leg in Texas," focussed primarily on the closure of small hospitals in remote, sparsely populated areas, attributing their financial problems to Medicare payment rates. Modern Healthcare's cover story heralded administrators in rural hospitals who, in its view, overcame virtually insurmountable obstacles to keep their institutions in the black.<sup>2</sup> In May, the Texas legislature voted overwhelmingly in favor of legislation designed to save rural hospitals. That action followed the report of a Special Task Force on Rural Health Care Delivery which identified "inadequate patient revenues as the single greatest threat to the viability of rural hospitals in Texas and ...availability and access to health care in rural areas."<sup>3</sup>

At the federal level, the Prospective Payment Assessment Commission (ProPAC), in its March 1989 Report, urged DHHS to continue its rural health care research and policy agenda.<sup>4</sup> In May 1989, the Congressional Research Service issued a report on rural hospitals. The report, requested by the House Committee on Appropriations, was in response to concern that "many more rural hospitals may face the prospect of closure in the near future, potentially compromising access to essential services in isolated areas."<sup>5</sup>

The Congress established lower Medicare payment rates for rural hospitals relative to urban hospitals when it introduced the Prospective Payment System (PPS). Moreover, as ProPAC's June 1989 Report to Congress noted, because PPS is a case-based payment system, "declines in admissions lead directly to decreased revenues."<sup>6</sup> This does not necessarily affect the rural populations' access to inpatient care, however, or even the hospitals' net revenues. The Congressional Research Service's report on rural hospitals

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1. Modern Healthcare, Nov. 11, 1988.

2. Modern Healthcare, April 28, 1989.

3. State of Texas, Special Task Force on Rural Health Care Delivery, Executive Summary, January 27, 1989.  
ProPAC, Report and Recommendations to the Secretary, U.S. Department of Health and Human Services March 1, 1989, p.7.

5. Mark Merlis, Rural Hospitals, Congressional Reports Service, May 1989.

6. ProPAC, Medicare Prospective Payment and the American Health Care System, Report to the Congress, June 1989, p. 6.



found that while the smallest rural hospitals had negative patient margins -- the ratio of revenues from patients and insurers to total operating costs -- the larger rural hospitals were doing better than their urban counterparts.<sup>7</sup>

Most of the research examining rural Medicare beneficiaries' access to inpatient care is conducted from the viewpoint of hospitals. This analysis is conducted from the viewpoint of the patient.

## SIGNIFICANCE OF THIS STUDY

This study employs a fundamentally different research approach called small area analysis. The basic unit of analysis is the Medicare beneficiary population residing in a defined geographic area.

Access is analyzed by focussing on the hospital admission patterns of Medicare beneficiaries for various categories of inpatient service. The statistical techniques for comparing rural and urban utilization patterns are adapted from classical epidemiology. A description of the technique for delineating one population area from another is found in the methodology section. Data sources and statistics used in the analysis are described in the technical appendix.

The Medicare population age 65 and over was chosen for this study because they are the largest consumers of medical care services, and are the group most affected by prospective payment. In addition, they comprise the only large patient group for which data are uniformly available from a single data base. There are, however, some limitations to the general applicability of the findings. First, there may be significant differences in the utilization patterns of the Medicare population and that of the younger, non-Medicare population. In particular, there is no information in this study on maternity-related care. Second, the study focuses exclusively on inpatient hospital utilization; access to other services and physicians is not examined, although the availability and quality of care in the primary network may influence hospitalization rates.<sup>8</sup> Third, the study is limited to five states. While these five states might be fairly representative, they may not adequately reflect the national experience.

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7. Mark Merlis, Rural Hospitals, Congressional Reports Service, May 1989 pp. 24-25.

8. John Billings and Victor Hasselblad, Use of Small Area Analysis to Assess the Performance of the Outpatient Delivery System in New York City. Monograph. Health Systems Agency of New York City and Codman Research Group, Inc. HSA of New York City, November 1989.

## METHODOLOGY

This study examines and compares hospital admission rates, adjusted for age and sex, for rural and urban Medicare beneficiaries for all Diagnosis Related Groups (DRGs). Population areas (PA) and DRGs were aggregated to larger categories to evaluate access for various classes of service within areas served by different types of hospitals. The per capita admission rates for each state and small area are standardized to the national Medicare rate, so that comparisons can be made between the areas and states; the per capita admission rates are expressed as ratios to the national Medicare average.<sup>9</sup>

### Procedures and Techniques

The study uses standard techniques for calculating age and sex adjusted admission rates, measures of variation and correlation, and tests of significance. These are described in the technical appendix. The study also classifies Medicare beneficiary populations by rural or urban location in order to assess their access to inpatient services for both routine and specialized medical and surgical care. The starting point for the analysis is the grouping of the Medicare beneficiary population into small geographic areas.

### Population Area Delineation

The size of the geographic area is extremely important for small area analyses. Differences between population use rates in small areas tend to be much greater than those between large areas. If the size of the area is too large, differences in local hospital resources and medical practice styles are combined and their influences obscured. Further, because variations in utilization patterns are generally local in origin, they need to be identified and understood at this level. The process used in this study establishes an association between the providers that most strongly influence local patterns of hospital use and the per capita admission rates of the Medicare beneficiaries living within the geographic area. This association is critical for assessing access to care if a local hospital closes or does not offer a range of services across medical subspecialties commonly used by Medicare beneficiaries.

Area delineation begins with the assembly of patient bill data for 100 percent of the Medicare beneficiaries living in the study states, including those who were hospitalized in other states. Distinctions between geographic areas are based on the frequency with which Medicare beneficiaries use specific hospitals. Separation between areas is determined by sorting the data abstracts by zip code and generating a frequency distribution of admissions by hospital. For example: zip code 00000 had 500 admissions: 300 of these admissions were to North Valley -- the "local" hospital -- 100 to Central Hospital, 50 more to Mid

9. The delineation of population areas and the generation of per capita hospital admission rates for Medicare beneficiaries nationwide was performed by the Codman Research Group as subcontractor to the American Medical Review Research Center under contract to the Department of Health and Human Services, Health Care Financing Administration, Health Standards and Quality Bureau (500-88-0004), for the project: Small Area Analysis of Variation in Utilization and Outcomes for Hospital Care among Medicare Beneficiaries 1984-1986.

Valley Hospital, and another 50 were spread among three "remote" (out-of-area) urban tertiary care hospitals. The array is distinctive and clearcut: 60% of the admissions are to one hospital, which accounts for three times as many admissions as the next most frequently used provider. Zip code 00000 is considered a "seed" and, at least temporarily, becomes the pivot for the development of a multi-zip code population area of Medicare beneficiaries who share the same pattern of hospital use. The entire Medicare population within the area is assigned to only one zip code.

The distribution of admissions among hospitals for each contiguous zip code is examined. A number is generated correlating the pattern of hospital use in the first zip code with that of any other zip code. Then the next zip code is examined. If the measurement of its use pattern is extremely close to that of the seed, a cluster is begun. The pattern of hospital use in every zip code is analyzed in this way for the degree of correlation with every contiguous zip code, its initial cluster assignment, and any other cluster. Regrouping of zip codes and areas is performed as needed until all of the hospitalizations associated with Medicare beneficiaries residing in every zip code within each state are assigned to a population area.

Ideally, a population area is defined so that its residents receive a plurality of their inpatient services from one or a small number of local providers. Occasionally, residents of a population area share a common pattern of use of a few nearby providers. Delineation of areas is based on the pattern of use for all admissions. All inpatient services by all providers, whether local or out-of-area, are accounted for in the analysis.

The pattern of hospital use for residents of two or more zip codes takes precedence in defining a population area if zip codes are not geographically contiguous. This situation occurs infrequently, however, generally when an interstate highway or bridge channels traffic in one direction more than another. Sometimes a zip code with a very small number of Medicare admissions could be assigned with equal validity to two areas. In those cases, decisions are based on geographic contiguity.

### **Classification of Population Areas, Provider Types and Case Types**

Once the small population areas are defined and identified as rural or urban, grouping of areas and admission categories is required to detect specific changes in Medicare beneficiaries' patterns of hospital utilization. Population areas are classified by type based on whether residents' inpatient service is local or remote. The study uses HCFA data to identify hospitals by bed size and category: rural, urban, sole community, rural referral. DRGs are aggregated to three summary and seven mutually exclusive case types.

### **Population Area Classification**

Population areas are classified based on criteria that could hypothetically limit access to inpatient services. The first is hospital bed size, with its implications for number and diversity of professional personnel and medical subspecialties. The second criterion is whether the hospital(s) providing the majority of medical care to Medicare beneficiaries is (are) local or remote. These categories are described in Exhibit 1.

## EXHIBIT 1: Rural Population Area Types

Type	Definition
1	Dominant <sup>a</sup> Local <sup>b</sup> Provider, <50 beds
2	Dominant Local Provider, >50 beds
3	Dominant Remote <sup>c</sup> Provider
4	Mixed: <sup>d</sup> Several Local Providers, none dominant
5	Several Local Providers with significant Remote hospital

- 1 Dominant<sup>a</sup> Local<sup>b</sup> Provider, <50 beds
- 2 Dominant Local Provider, >50 beds
- 3 Dominant Remote<sup>c</sup> Provider
- 4 Mixed:<sup>d</sup> Several Local Providers, none dominant
- 5 Several Local Providers with significant Remote hospital

- a. A hospital is "dominant" if it accounts for a plurality of the area residents' admissions.
- b. A hospital is "local" if 40% or more of its admissions originate in the area.
- c. A hospital is "remote" if fewer than 40% of its admissions originate in the area.
- d. An area is "mixed" if several hospitals, none dominant, provide care to residents of the geographic area.

These groupings facilitate examination of access to inpatient hospital services in specific circumstances. For example, is access impaired for beneficiaries served by a single, small, dominant provider if the hospital offers a very limited range of services (Type 1). Similarly, are inpatient services for Medicare beneficiaries in rural areas who depend heavily on a remote provider limited because of geographic distance or poor referral practices (Type 3).

### Provider Classification

Providers are classified by urban and rural location, bed size, and type of provider. Change in the volume and percentage of admissions to specific types of rural hospitals can be examined in the context of changes in the per capita admission rates of rural beneficiaries. These classifications are illustrated in Exhibit 2.

## EXHIBIT 2: Provider Type Classifications<sup>a</sup>

Rural	Urban
sole community	<100 beds
sole com/rural referral	100-249 beds
rural referral	250-404 beds
rural < 100 beds	405+ beds
rural 100-169 beds	
rural > 170 beds	

- a. Some hospitals were not designated as rural or urban in the data sources used in this study and described in the technical appendix. Admissions to Not Designated hospitals were 9% of total admissions in IL; 5% in MT; 22% in AL; 15% in CA; 10% in TX. These appear to have been randomly distributed between rural and urban locations.

### Case Type Classification

DRGs were aggregated to form ten case types so as to identify changes in the composition of inpatient services used by rural Medicare beneficiaries. Within the total medical and total surgical categories, DRGs were divided into two groups according to whether the majority of rural beneficiaries' admissions occur in local rural hospitals or involve a mix of local and out-of-area, largely urban, facilities. Minor surgical procedures for which outpatient surgery became increasingly common after 1984 were excluded from both local and mixed surgery categories so that change in these admission rates would not be distorted by alternate site selection. The technology intensive case type consists of those DRGs involving a high degree of medical specialization and capital intensive technologies usually available only in some rural referral centers and large urban hospitals. The low variation case type consists of those DRGs which are least sensitive to physician practice style or resource availability and are considered to reflect most accurately the actual incidence of illness.<sup>10</sup> These classifications, which are mutually exclusive except for the first three aggregate categories, are described in Exhibit 3. The DRG composition of each case type is described in the technical appendix.

EXHIBIT 3: Case Type Classifications

Case Types	Definition
Total Admissions	All inclusive
Total Medical	All non-surgical DRGs
Total Surgical	All surgical DRGs
Medical-Local	Local, often small, hospitals account for a majority of admissions. This category includes 8 of the 10 most frequently admitted medical conditions among Medicare beneficiaries nationwide, among them pneumonia and congestive heart failure.
Medical-Mixed	A third or more of the admissions are to rural referral centers or large urban hospitals.
Surgical-Local	Local, often small, hospitals account for a majority of admissions. This type includes transurethral prostatectomy and small and large bowel operations, among the highest volume procedures for the Medicare population.
Surgical-Mixed	A third or more of admissions are to rural referral centers or large urban hospitals.
Technology-intensive	Large rural and urban hospitals dominate for these procedures and treatments. Examples include various cardiac procedures, including coronary artery bypass grafts, joint replacement surgery, and chemotherapy and radiology treatments.
In/Out-Patient	Procedures where treatment in the outpatient setting is common
Low Variation	Medical conditions and surgical procedures for which strong consensus exists on the need for hospitalization for treatment of a condition or to perform a certain procedure. Local hospitals account for most of the admissions. It includes 2 of the 10 medical conditions — heart attack and stroke — with the highest volume in Medicare nationwide and 3 of the 5 highest volume surgical procedures.

10. John E. Wennberg and Alan J. Gittelsohn, "Variations in Medical Care among Small Areas. Scientific American; 1982, 246:120-129.

## STUDY FINDINGS

In four of the five states studied, more Medicare beneficiaries lived in urban areas than in rural areas. The proportions varied greatly, from only 7 percent in California to 41 percent in Alabama (Table 1). Only Montana had more Medicare beneficiaries living in rural than in urban areas (84%). In addition, most of the rural beneficiaries lived in areas where there is one dominant provider.

TABLE 1: Number of Rural Medicare Beneficiaries by State and as Percent of Total Medicare Population by Rural Area Type (1986)

	Alabama	California	Illinois	Montana	Texas
Rural Population	195,575	197,710	354,365	180,553	933,308
% Total Medicare	41.0	7.0	26.0	84.0	28.0
<u>Rural Provider Areas</u>	%	%	%	%	%
Dom.Local, <50 beds	11.0	2.0	2.0	22.0	6.0
Dom.Local, >50 beds	24.0	4.0	19.0	57.0	15.0
Dom.Remote	0.0	0.1	0.4	0.2	0.4
Multi.Local	2.0	0.6	4.0	2.0	0.1
Multi.Local/Sig.Remote	4.0	0.3	1.0	3.0	6.0

### Changes in Admission Rates in Rural Areas

In all five study states, per capita admission rates of Medicare beneficiaries living in rural areas were higher than for Medicare beneficiaries in urban areas. The difference between the two populations is diminishing, however, judging by results of this analysis. Table 2 shows the number of admissions and the adjusted per capita admission rates for rural and urban populations in the five study states and for the combined five-state area.

The per capita admission rate for Medicare beneficiaries living in rural areas was 22.1 percent higher than for those living in urban areas in 1984, and 17.1 percent higher in 1986. Between 1984 and 1986, admission rates in rural areas declined 4 percent more than in urban areas (Table 2). However, the per capita admission rate for rural Medicare beneficiaries remained at or above the national Medicare average in all five states. Differences in the admission rates for both urban and rural beneficiaries in the study states are statistically significant when compared to the national Medicare rate ( $p < .001$ ).



TABLE 2: Number of Admissions and Admission Rates for Medicare Beneficiaries: 1984-1986 (Total Admissions)

Population	Number of Admissions <sup>a</sup>		Pct. chg.	Adjusted Admission Rate <sup>b</sup>		Pct. chg.
	1984	1986		1984	1986	
Rural	529,087	440,884	-17	431.53	337.49	-22
Urban	1,666,522	1,476,170	-11	353.37	288.13	-18
5-state	2,141,297	1,867,412	-13	369.74	298.02	-19

a. The 5-state total excludes admissions of Medicare beneficiaries in neighboring states, which are included in each small rural or urban areas. Thus the total for rural and urban combined is slightly larger than that for the five states.

b. Rate per 1,000 beneficiaries adjusted for age and sex.

The data in Table 3 describe the admission rates of rural Medicare beneficiaries in each state relative to the national Medicare rate. Overall, the admission rate among the five study states declined by 19 percent during this period. Each column of the table examines changes in the ratio of rural beneficiaries' admission rates in each state relative to (a) the admission rate of urban beneficiaries, (b) the state average admission rate, and (c) the national Medicare average.

Rural Medicare beneficiaries' hospital admission rates were uniformly higher than those of beneficiaries in all the study states. The range between states in the ratio of rural to urban admission rates in 1984 was great, from 5 percent higher in California to 48% higher in Texas. In Alabama, California, and Illinois, the ratio of rural to urban admission rates was virtually unchanged between 1984 and 1986, which means that the rate of decline in admission rates was similar for both urban and rural beneficiaries during the three year period. In Montana and Texas, however, the per capita admission rates of rural and urban beneficiaries in 1984 were 18 percent and 48 percent higher, respectively, than for urban beneficiaries, but only 4 percent and 9 percent higher in 1986. Especially in Texas, then, admission rates for Medicare beneficiaries in rural areas declined more rapidly than those for beneficiaries residing in urban areas.

Because rural Medicare beneficiaries constituted 84 percent of the total Medicare beneficiary population in Montana in 1986, the state average admission rate is essentially equivalent to the rural rate. In California, where rural beneficiaries constitute only 7 percent of the population, they have almost no influence on the state Medicare average admission rate. Medicare beneficiaries in rural areas in California were admitted 5 percent more frequently than were beneficiaries in urban areas. The ratios of rural Medicare admission rates to the state averages in Alabama and in Illinois changed very little between 1984 and 1986. In Alabama, Illinois, and California, then, the decrease in admission rates of rural beneficiaries was gradual. In Texas, however, where rural beneficiaries represent just over one-quarter of the total Medicare population, the decline in the ratio of rural admissions to the state average was dramatic and suggests a disproportionately large decrease in the admission rates in rural areas.

TABLE 3: Ratios of Rural Medicare Beneficiaries Admission Rates to Urban, State, and National Medicare Average Rates (Total Admissions)

Population	Rural/Urban Areas		Rural/State Avg.		Rural/ Natl.Avg.	
	1984	1986	1984	1986	1984	1986
Alabama	1.14	1.13	1.08	1.07	1.25	1.30
California	1.05	1.06	1.05	1.05	0.91	0.93
Illinois	1.10	1.11	1.07	1.07	1.15	1.13
Montana	1.18	1.04	1.01	1.00	1.03	1.15
Texas	1.48	1.09	1.13	1.06	1.30	1.09

The data describing the ratio of rural Medicare beneficiaries' admission rates relative to the national Medicare average show that in Alabama, California, and Montana, admission rates in rural areas declined less rapidly than for the Medicare population nationwide. In Illinois and Texas, however, the decrease in the admission rates of rural beneficiaries exceeded the 17 percent decrease recorded nationally, although the admission rates of Medicare beneficiaries living in rural areas of both states were still higher than the national Medicare average in 1986.

The ratio data in Table 3 clearly demonstrate that the adjusted per capita admission rates of rural Medicare beneficiaries are still above the national Medicare average for total admissions, except in California, where the rates for both urban and rural populations are 7 to 10 percent below the national average rate.

### Changes in Admission Rates by Case Type

The effect of decreasing admission rates is felt disproportionately in rural hospitals. This is because the volume of admissions has fallen more for rural hospitals than for urban hospitals. Admissions for simple pneumonia, congestive heart failure, and other often chronic conditions (medical-local), are a major component of cases in small rural hospitals. Table 4 shows that rural beneficiaries' admission rates for these conditions declined 25 percent between 1984 and 1986, while the decline for urban populations during the same period was 18 percent. Patients with these conditions make up about 50 percent of rural hospitals' admissions overall, 60 percent or more among the smallest rural hospitals, but only 46 percent of urban hospitals' admissions. Therefore, the greater decrease in rural admission rates affected most rural hospitals more severely.

Medical conditions account for approximately two-thirds of all Medicare admissions. Per capita hospitalization rates tend to be more variable than for any surgical case type. Several studies have found that admission rates for medical conditions vary relative to the



availability of hospital beds.<sup>11</sup> Admissions for medical conditions are extremely important to review, because the medical-local category includes eight of the ten highest volume Medicare admission categories. Further, all eight have been classified by Wennberg as "high variation" admission categories in which there is weak consensus among physicians on the need for hospitalization. Admission rates for these conditions are also sensitive to the availability or quality of ambulatory care resources.<sup>12</sup>

Admission rates for conditions and procedures for which physicians have a relatively strong consensus on the diagnosis, the appropriate site of treatment (hospital) and the type of treatment required, typically show much less variation between and among populations or over time. These are called "low variation" because the admission rate is less affected by physician practice style: patients who are diagnosed as having a heart attack (acute myocardial infarction) or gastro-intestinal hemorrhage will all be hospitalized under virtually any circumstances. Most hospitalizations for these conditions and procedures occur in local hospitals. Distinguishing these conditions from those where physicians have more discretion helps differentiate between admissions that vary because of the level of illness and those where factors such as physician practice style or the availability of beds or of outpatient alternatives influence the decision to hospitalize.

Admission rates for medical and surgical DRGs characterized as low variation declined by 10 percent among rural beneficiaries, less than half the decrease in medical-local admissions between 1984 and 1986. Among urban beneficiaries, the admission rate for the low variation case type was lower in all three years and the percent decrease was also greater. In both Medicare populations, component medical DRGs -- stroke (specific cerebrovascular disorder), heart attack (acute myocardial infarction), and gastro-intestinal hemorrhage -- accounted for virtually all the decrease in admission rate for the low variation case type.

TABLE 4: Admission Rates of Medicare Beneficiaries for Local Hospital-Focused Case Types, 1984-1986

Case Type	Rural Beneficiaries		Adjusted Admission Rates <sup>a</sup>		Urban Beneficiaries		Pct. chg.
	1984	1986	Pct. chg.		1984	1986	
Medical-Local	226.36	170.85	-25		163.57	133.74	-18
Surgical-Local	31.03	30.01	-3		29.68	27.94	-6
Low Variation	48.18	43.43	-10		42.40	36.96	-13
In/Out Option	24.04	6.07	-75		23.40	5.92	-75
TOTAL LOCAL	329.52	250.11	-24		259.06	204.45	-21

a. Rates per 1,000 beneficiaries adjusted for age and sex.

11. John E. Wennberg, "Dealing with Medical Practice Variations: A Proposal for Action," *Health Affairs*, 1984; 3(2):6-32.

12. John Billings, *Ibid.*

The dramatic 75 percent decrease in the rate of in-patient services for procedures which can be performed in the out-patient setting (in/out option) can be accounted for largely by the number of Lens Procedures (DRG 39) that migrated to the out-patient setting. With these minor surgeries excluded, the admission rate for total surgery decreased by only 4 percent for the five study states, from 79.86 admissions per thousand beneficiaries to 76.66. Both the admission rate and the percent decrease between 1984 and 1986 were virtually identical for rural and urban Medicare beneficiaries. Among the routine surgical procedures classified as surgical-local, rural beneficiaries' admission rates remained higher than for urban beneficiaries and the percent change within the three year period was half that for urban beneficiaries.

In every rural area, Medicare beneficiaries' admission rates for surgery performed in local hospitals were higher than the national or urban rates except in California. Although the rates in California were lower, admission rates of beneficiaries in rural areas were higher than in urban areas. Routine, locally performed surgery accounts for about twice the volume of subspecialty surgery for the Medicare population.

Table 5 presents data contrasting rural and urban Medicare admission rates for case types involving some degree of medical subspecialties and high technology. These cases are usually admitted either to rural referral centers or large urban hospitals. They have never represented a substantial portion of admissions for small hospitals, whether rural or urban. Rural Medicare beneficiaries' admission rates for rapidly developing high technology- or expertise-intensive procedures and treatments can be an important index of access. This is because rural beneficiaries' use rates have been lower than urban beneficiaries' use rates in the past. It is also the only category of inpatient service where utilization rates have been increasing. Finally, because most rural hospitals do not offer these services, rural beneficiaries must find them either in rural referral centers or large urban hospitals.

TABLE 5: Admission Rates of Medicare Beneficiaries for Referral Hospital-Focussed Case Types: 1984-1986

Case Type	Adjusted Admission Rates <sup>a</sup>					
	Rural Beneficiaries			Urban Beneficiaries		
	1984	1986	%	1984	1986	%
Medical-Mixed	62.42	47.23	-24	53.03	42.13	-21
Surgical-Mixed	16.85	16.19	-4	17.45	17.45	0
Tech-Intensive	22.56	23.70	5	24.02	25.02	4
TOTAL SPECIALTY	101.83	87.12	-14	94.50	84.60	-10

a. Rates per 1,000 beneficiaries adjusted for age and sex.

The greatest difference in the adjusted admission rates between study years and between Medicare beneficiaries living in rural and urban areas exists for the medical-mixed case. This is consistent with the historic pattern of rural admissions. Additional research, including the use of Medicare Part B physician services, would help determine whether rural beneficiaries' higher admission rates for medical conditions, regardless of hospital location, are correlated with the quality, quantity, and intensity of primary care services in rural areas.

No state in the study and no rural population area type had admission rates below the national Medicare rate for total surgery. Per capita admission rates for total surgery also varied within a very narrow range relative to medical admissions. Among procedures where rural referral centers and urban hospitals dominate (surgery-mixed), however, admission rates are slightly lower for rural beneficiaries than for urban beneficiaries. Neither the rural nor the urban admission rate among the study states differs significantly from the U.S. admission rate for the surgery-mixed case type.

### Effects of Decreasing Admission Rates on Rural Hospitals

Data presented in the preceding sections focussed on rural beneficiaries' access to care as measured by their per capita admission rates for various categories of services relative to the admission rates of urban beneficiaries. Data in the following section examines admission patterns from the hospital's perspective.

Large reductions in the volume of admissions affected a rural hospital more than change in its percent of local Medicare residents' admissions for any case type. A 25-bed hospital in rural Texas, for example, might account for 50 percent of the local Medicare population's admissions for pneumonia in both 1984 and 1986, but the number of patients admitted for pneumonia decreased during the period from 40 to 15. As Table 6 records, there is little change between 1984 and 1986 in the percent of Medicare beneficiaries' admissions made to rural hospitals. Table 7, however, shows that decrease in the volume of admissions to rural hospitals was substantial. The percent change in volume was not equally distributed between rural and urban providers or among rural provider types. The percentage decrease in the volume of admissions among rural hospitals in Alabama, Illinois, and Texas exceeds the reduction experienced by urban hospitals in each state. Rural hospitals in Texas, for example, had 38 percent fewer Medicare admissions, compared to a decrease of 21 percent for all Texas hospitals. Research by ProPAC based on data from all hospitals nationwide, also found substantial differences in average Medicare caseload between rural and urban hospitals.<sup>13</sup>

Among the rural provider types, hospitals with fewer than 50 beds lost not only admission volume but also received a smaller share of total admissions. Larger rural hospitals gained in market share. Among urban areas as well, the largest hospitals most often improved their market positions.

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13. ProPAC, Report to Congress, June 1989, p. 13ff.

Hospitals with declining market share typically have 50 or fewer beds, draw 70 to 90 percent of their patients from a small community, and provide 50 percent or less of the total in-patient care for residents of that community, who go elsewhere for the remainder. For example, a 26-bed facility in rural California receives 84 percent of its Medicare admissions from 4 zip codes. Although the hospital's total occupancy rate was less than 30 percent in 1986, it accounted for only 49 percent of inpatient hospital care for the Medicare beneficiaries living in the 4 zip codes. Even if the Medicare admission rate in this rural California community were to drop below the average for other rural areas or the state, it would be difficult to attribute the low utilization rates solely to factors associated with the local hospital.

Closure of a rural hospital could affect utilization rates of Medicare beneficiaries living in its immediate vicinity. Valid information on closures was not available in this study. However, a related inquiry on the impact of rural hospital closures on local Medicare beneficiaries' utilization patterns has been conducted for the U.S. General Accounting Office (GAO) and will be released in early 1990.<sup>14</sup>

TABLE 6: Percent of Medicare Admissions Made to Rural Hospitals (Total Admissions)

Year	AL	CA	IL	MT	TX
1984	27%	7%	24%	69%	23%
1986	26%	7%	23%	68%	21%

TABLE 7: Volume of Medicare Admissions 1984-1986 (percent change, Total Admissions)

Providers	AL	CA	IL	MT	TX
All Hospitals	-7%	-8%	-15%	-1%	-21%
Rural Hospitals	-10%	-5%	-20%	-1%	-38%
Urban Hospitals	-7%	-9%	-16%	0%	-21%

### Effects of Changing Medicare Case Mix on Rural Hospitals

Approximately 25 percent of rural Medicare beneficiaries live in areas dominated by a hospital of 50 or fewer beds. Almost all the remainder live in areas served by hospitals of 50-170 beds. The data in Tables 8 and 9 suggest how the volume of Medicare admissions for specific categories of care affects the rural hospitals' financial position, especially those of fewer than 50 beds where most admissions are medical rather than surgical DRGs.

14. The work performed by the Codman Research Group is part of a much broader study undertaken by G.A.O. staff on the Impact of Rural Hospital Closures on Access to Inpatient Services.

As Table 8 reveals, the percentage of Medicare admissions to rural hospitals is nearly equivalent to the percentage of beneficiaries living in rural areas only for the medical-local case type. However, admission rates declined most sharply between 1984 and 1986 for the medical-local case type. In Texas, for example, the admission rate decreased by 37 percent, from 263 to 166 per thousand rural beneficiaries. The percent of Medicare beneficiaries using rural hospitals for surgical admissions, which have higher average DRG payments, is substantially less than for medical admissions.

Medicare beneficiaries in all the rural areas are increasing their per capita rates of utilization of technology-intensive care, even as utilization of other services is declining. Except in Montana, however, where most of the Medicare population lives in rural areas and is served by rural providers, rural hospitals in the aggregate -- that is, including the larger rural referral centers -- account for only 3 to 12 percent of Medicare admissions for technology-intensive treatments and procedures.

TABLE 8: Rural Hospital Admissions as Percent of Total Medicare Admissions, 1986

Case Type	AL	CA	IL	MT	TX
% Beneficiaries Rural	41%	7%	26%	84%	28%
Total Admissions	26%	7%	23%	68%	21%
Total Surgical	17%	5%	19%	56%	13%
Medical-Local	31%	8%	27%	74%	26%
Tech-Intensive	12%	3%	12%	44%	8%

Table 9 shows that in 1986 rural hospitals were still providing the majority of inpatient services to rural beneficiaries in all the states for the medical-mixed case type. In California, Illinois, and Montana, rural hospitals also account for two-thirds of the admissions of rural beneficiaries for surgery-mixed, and in Alabama and Texas, they account for almost half these admissions. In Montana, rural hospitals account for just over half of the rural beneficiaries' admissions. Only for the technology-intensive case type do most rural beneficiaries use urban hospitals.

TABLE 9: Rural Hospital Admissions as Percent of Total Rural Medicare Admissions, 1986

Case Type					
Medical-Mixed	63%	82%	73%	79%	61%
Surgical-Mixed	43%	69%	66%	63%	44%
Tech-Intensive	29%	42%	46%	53%	29%

The data in Table 10 suggest that this imbalance may be increasing: the volume of technology-intensive admissions declined in rural hospitals in Alabama by 6 percent and in Texas by 2 percent while that in urban hospitals increased by 16 percent and 18 percent

TABLE 10: Change (Percent) in the Volume of Technology-Intensive Medicare Admissions to Rural and Urban Hospitals, 1984-1986

Provider	AL	CA	IL	MT	TX
Rural Hospitals	- 6	4	9	9	-2
Urban Hospitals	16	12	10	25	18

respectively. In California and Montana, the increase in rural hospital admissions was just one-third that in urban hospitals. Only in Illinois were the volume increases roughly equivalent. DRG payments are three to five times higher on average for such technology-intensive services than those for routine medical conditions such as pneumonia. However, the smallest rural hospitals see few of the dollars this generates.

### Convergence of Patterns between Rural and Urban Medicare Populations

Changes in the volume of admissions, per capita admission rates, and sites of service of rural Medicare beneficiaries directly affect the costs of care, and potentially influence its appropriateness. In the past, rural Medicare populations have used technology-intensive care less frequently than urban populations. This situation has begun to change, however. As admissions for specialized and technology-intensive treatments and procedures make up a larger proportion of medical care for both rural and urban populations, costs to the Medicare program will rise. Rural referral centers receive some of the rural beneficiaries' admissions and hence the revenue they generate. Smaller facilities are unequipped to offer the services owing to the cost of expensive equipment and the absence of trained professional and technical personnel to perform the services or operate the equipment. Moreover, several studies have shown that outcomes of technology-intensive treatments and procedures such as coronary artery bypass grafts are best in medical centers where they are performed frequently.<sup>15</sup>

It is not known whether the utilization patterns characteristic of urban Medicare beneficiaries represent appropriate levels of admissions for the rural Medicare populations. This study does not provide data on which to base assessments of quality. It is generally assumed, however, that large differentials between urban and rural admission rates are undesirable and that the convergence of admission rates for the two populations for all types of service implies more equitable access.

Table 3 documented the gradual narrowing of the difference between overall admission rates for rural and urban Medicare beneficiaries. Tables 4, 5, and 8 examined trends toward convergence in the admission rates for specific admission categories of inpatient services. Table 11 presents additional evidence of convergence in the admission rates for

15. J. E. Showstack, K.E. Rosenfeld, D.W. Garnick, H.S. Luft, R.W. Schaffarzick, J. Fowles, "Association of Volume with Outcome of Coronary Artery Bypass Graft Surgery," *JAMA*, Feb. 13, 1987, Vol. 257, No. 6, pp.785-789.



rural and urban beneficiaries using statistical measures of variation for each admission category. The systematic component of variation (SCV), the coefficient of variation, and the ratio of the highest admission rate to the lowest rate all measure variation across the spectrum of rural and urban locations for each admission category. For each measure, the lowest numbers represent the least variation in the admission rates between and among rural and urban areas. With one exception, the SCV is lower in 1986 than in 1984, indicating diminishing differences in admission rates of all Medicare beneficiaries.

Although the SCV for the least variable admission category (low variation) increased slightly, it is still very low and the ratio of the highest rate area to the lowest did not change. Disaggregation of the DRGs in the low variation case type reveals that the medical components of this admission category are more variable than the surgical components.<sup>16</sup>

TABLE 11: Measures of Variation in Adjusted per capita Admission Rates of Medicare Beneficiaries for Selected Case Types: 1984-1986

Case Type	Year	SCV	CV	H/L ratio
Total Admissions	1984	20.5	.123	1.6
	1986	18.3	.116	1.6
Total Medical	1984	38.2	.166	1.9
	1986	28.2	.146	1.8
Total Surgical	1984	6.8	.077	1.8
	1986	6.4	.080	1.6
Tech-Intensive	1984	17.3	.128	2.1
	1986	6.9	.084	1.6
Low Variation	1984	5.8	.075	1.3
	1986	9.0	.091	1.3

16. Diagnosis Related Group (DRG) coding which was introduced with PPS was relatively new in 1984, and by 1986 there is evidence that coding accuracy for conditions such as heart attack (acute myocardial infarction) had improved. Since the DRGs for most surgical procedures are specific and narrowly defined, relative to those for medical conditions, differences between geographic areas, hospitals and physicians in coding conventions are less likely to contribute to variation in admission rates for surgical procedures compared to medical admissions. The phenomenon known as DRG creep may also be a source of variation in medical components of the low variation case type in this early period of PPS. For example, some of the areas in the study appeared to reduce their rate of admissions for transient ischemic attack with a proportionate increase in admissions for stroke (specific cerebrovascular disorder).

## Identifying Potential Problems

While there is no evidence that access to care has been impaired for Medicare beneficiaries who reside in rural areas in the five states, there is a need for continued review. Medicare beneficiaries living in rural areas where the dominant provider has fewer than 50 beds (Type 1) had the highest adjusted admission rates for all case types for which most admissions were to the local hospital. Admission rates for this group of Medicare beneficiaries declined the most between 1984 and 1986. In Alabama, 33 percent of rural Medicare beneficiaries lived in areas served by such small hospitals, in Texas about 28 percent. These under 50 bed hospitals are the most susceptible to closure.<sup>17</sup> Moreover, residents of these areas receive 75 percent or more of inpatient services involving medical or surgical subspecialties or high technology from remote providers.

The number of beneficiaries subject to these conditions is small, however: they represented only one-quarter to one-half of one percent of the total Medicare population in 1986. Admission rates in these areas show the most fluctuation, because of the very small numbers in each admission category. Nonetheless, utilization patterns for these populations can be monitored so that pockets of underservice can be avoided or eliminated.

## Summary

Among the five states examined in this study, it appears that access to inpatient services for rural Medicare populations is not impaired despite decline in use of rural hospitals and the closure of some. The findings of this study, particularly those relating to elective surgery and technology-intensive care, indicate that residents of rural areas are able to obtain inpatient services at rates that are comparable to those of urban populations in their own states and to the national Medicare average. The mix of services consumed by rural Medicare beneficiaries is changing. The large decreases in admission rates for medical DRGs, especially in the medical-local case type, along with modest but significant increases in the use of technology-intensive care, imply that rural beneficiaries will increasingly use the larger rural hospitals and urban hospitals for a growing percentage of their inpatient services. Overall, the utilization patterns of Medicare beneficiaries in rural areas are becoming more like those of urban beneficiaries both in terms of per capita admission rates and the mix of clinical services they consume.

There is relatively little change in the volume or per capita rate of admissions for case types for which strong consensus exists among physicians on the need for hospitalization for treatment of the condition or the appropriateness of a particular procedure. The largest decreases in admission rates of Medicare beneficiaries have occurred for medical conditions where there is relatively weak consensus on the need for hospitalization. Medical conditions falling into this category represented the largest component of rural hospitals' admissions. While admission rates for these conditions decreased in both urban and rural areas, the decline was steepest for Medicare beneficiaries living in rural areas. Rural

17. PROPAC Annual Report to Congress, June 1989, pp.131 ff; and Merlis, Rural Hospitals, Congressional Research Service, May 1989.



hospitals, especially those with fewer than 50 beds, experienced the greatest reduction in the volume of Medicare admissions. Rural hospitals generally retained their market share of Medicare admissions for medical conditions and surgical procedures which formed the largest components of these hospitals' admissions in the past, but the volume of these admissions has been greatly reduced.

Medicare beneficiaries living in rural areas are consuming more specialized inpatient services which the small rural hospitals have never provided. Thus care received in large rural and large urban hospitals makes up a larger proportion of rural beneficiaries' total admissions. In addition, there is no statistically significant difference between the admission rates of rural and urban beneficiaries for surgery involving medical subspecialties, indicating that rural populations have access to the rural referral centers and larger urban hospitals where such care is generally provided.

## TECHNICAL APPENDIX: Part I: Data Sources

The study used two data sets from the Health Care Financing Administration (HCFA) for calendar years 1984 through 1986 obtained under contract 500-88-0004 and analyzed by the Codman Research Group as part of a project with the American Medical Review Research Center entitled "Small Area Analysis of Variation in Utilization and Outcomes for Hospital Care Among Medicare Beneficiaries, 1984-1986."

The first data set was a modified, expanded MEDPAR file containing a patient billing record of each hospital admission/discharge for all Medicare beneficiaries hospitalized in acute care hospitals at any point during the years covered by the data base. These admissions served as the numerator file for the analysis. Data elements included patient age, sex, zip code of residence, DRG diagnosis code, length of stay, admission date, discharge date, charges, and health insurance claim (HIC) number.

The second data set was a HISKEW (enrollment) file for the corresponding years containing demographic information on the Medicare eligible population, including age, sex, zip code of residence, and HIC number. This served as the denominator for the analysis.

### Data Qualifications and Assumptions

1. **Population Covered by the Study:** The analysis covers the hospital care of Medicare beneficiaries aged 65 or older. Medicare enrollees under the age of 65 were excluded based on the age of the patient/beneficiary at the time of admission recorded in the MEDPAR data file.
2. **Exclusions from the Data Base:** Medicare enrollees listed in the HISKEW file who were under the age of 65 were excluded. However, the HISKEW population file was converted to person years of eligibility in order to account for enrollees who became eligible (i.e., turned 65) during the year.
3. **Data Adjustments:** The HIC number was used to link the HISKEW and MEDPAR files and make systematic comparisons to establish consistency. Minor inconsistencies were identified, such as incorrect reporting of patients' zip codes by hospitals or partial year residency. For example, a small percentage of records revealed inconsistency between the zip code recorded on the MEDPAR record and that in the HISKEW file. For all records which had matching HIC numbers -- the vast majority -- the zip code recorded in the HISKEW file was used. Where a mismatch also existed in the HIC number, the HIC and the zip code from the MEDPAR file were used. No systematic bias in the mismatched HICs was detected. It therefore can be assumed that there was no distortion in the per capita rates by Population Service Area.
4. **Invalid Zip Codes:** Records of hospital discharges containing invalid zip codes were excluded. The exclusions were based on comprehensive United States Postal Service Zip Code files. They represent an extremely small number (perhaps a tenth of a percent) relative to the total records analyzed.

### Rural and Urban classifications

Rural or urban residence was established at the zip code level using U.S. Census Bureau criteria of location within a Metropolitan Statistical Area (MSA). This criterion is used for categorizing Populations as rural or urban. Hospitals were classified as rural or urban using HCFA data supplied by the Prospective Payment Assessment Commission (ProPAC); additional data on location, bed size and provider type were supplied by the U.S. General Accounting Office (GAO)

Community/place names for zip codes were obtained from the U.S. Postal Service which also provided information on changes in zip codes (additions, deletions, or reassignments of populations).

Cross-state population areas, defined by patient destination analyses, may be inclusive of communities on both sides of a state border. The area population (denominator) is comprised of residents of zip codes of both states. Hospitalizations (numerator) of area residents are counted in the cross-state area rate regardless of where they receive care.

## TECHNICAL APPENDIX: Part II: Population Area Delineation

CRG uses hospital patient billing abstracts for Medicare beneficiaries from every acute care provider in each state to define Hospital Market Areas (HMAs). However, the primary focus of interest is the health care experience of a defined population, not on the institutions where the population receives its care. This focus on the population's utilization patterns is critical if one is concerned with issues such as what happens to the hospital admission rate for a defined population if a local hospital closes or is no longer functioning as a full-service institution. For example, a small hospital's admission base is often extremely localized: 70-100% of its total Medicare admissions may derive from beneficiaries living in one to five zip codes in its immediate vicinity. On the other hand, beneficiaries living in these zip codes may be receiving most of their care from other providers. If one looks at North Valley Hospital, for example, beneficiaries residing in just two zip codes make up 96% of the hospital's clientele. Yet some 50% of their care and over 65% of their dollars go to other hospitals outside the North Valley area.

The accuracy of market area delineation from the perspective of the population is important if one is to be able to link their patterns of admissions with the providers that influence them most. Let us say that Medicare beneficiaries living in Fairview are admitted for Transurethral Prostatectomies and Hysterectomies at twice the average for Medicare enrollees in the state. The local hospital is North Valley Hospital, but physicians there perform only 18 percent of the prostatectomies on Fairview residents, and 54 percent of the hysterectomies. An investigation of the adequacy of access to these procedures requires that one take into account the other hospitals that influence the admission pattern for beneficiaries living in Fairview.

### Methods

Separation between Medicare populations defined by geographic area begins with the assembly of 100 percent of the patient billing abstracts sorted by zip code. Within each zip code, a frequency distribution of the admissions by hospital is done. For example, zip code 00000 had 500 admissions, with 300 of the 500 going to North Valley, the local hospital, 100 to Central Hospital, 50 more to Mid Valley Hospital, and another 50 were to more distant metropolitan hospitals. This array is distinctive and clearcut: 60% of the residents admissions are to one hospital, and that hospital accounts for three times as many admissions as the next most frequently used hospital. The zip code is considered a "seed" and becomes the pivot for the delineation of a multi-zip code area.

This process is repeated for each contiguous zip code. An algorithm is used to assign a score to measure the correlation between the pattern of hospital use in the seed zip code and that in any other zip code. If the score is close to that of the seed, a cluster is begun. The pattern of hospital use in every zip code is analyzed in this way for the degree of correlation to every contiguous zip code, to its initial cluster assignment, and to any other cluster. Ultimately, 15-20 correlation scores are examined for every single zip code, with regrouping of zip codes and areas as necessary until all the hospitalizations associated with every zip code within the state assigned to a "small area."

Ideally, each population area is defined so that the resident Medicare beneficiaries receive at least a plurality of their in-patient services from local providers. Occasionally, an area is created which has no in-area provider but where the residents all share a common pattern of use of a small number of nearby hospitals. Areas are delineated based on the pattern of distribution for total admissions. Thus it is not unusual for residents to be admitted to out-of-area hospitals for some or all of certain specialty services such as Coronary Artery Bypass Surgery. All admissions to all hospitals are included in the analysis.

Similarity of hospital use pattern for residents of a single zip code take precedence over geographic contiguity in defining a small area on the extremely rare occasions when they do not coincide. The exceptions generally occur where there is an interstate highway or bridge that channels patient flow around a lake, mountain range, or other natural obstacle. Sometimes a zip code will have a very small number of admissions which distribute equally between hospitals in two areas and could thus be assigned with equal validity to either one. In such cases, the decision is based on geographic contiguity.

### Plurality Rule

All the population within a single zip code is assigned to one small area based on the plurality of admissions to one or a few in-area hospitals. For example, residents of 10002 use Hospital A for 40 percent of their admissions, Hospital B for 15 percent. Both Hospital A and Hospital B are located in Zip code 10002, which together with 10003-10007 make up the Fairview area. Hospitals C and D, located in Zip code 10010, which together with zip codes 10011-10015 comprise the Hillside area, account for 10 percent and 5 percent respectively of Zip code 10002 Medicare residents' admissions. These out-of-area admissions are counted in the age/sex adjusted admission rate for Fairview area residents.

## TECHNICAL APPENDIX: Part III: Detailed Statistical Methods

### Indirect Age/Sex Adjustment and Calculation of Standard Rate

A standard epidemiologic technique known as "indirect age and sex adjustment" is used to adjust for age and sex. The denominator file for the population is sorted into age/sex cells at five year intervals, as illustrated below:

age 65-69 male	age 65-69 female
age 70-74 male	age 70-74 female
age 75-79 male	age 75-79 female
age 80-84 male	age 80-84 female
age 85-89 male	age 85-89 female
age 90-94 male	age 90-94 female
age 95- male	age 95- female

An age/sex-specific rate for the entire population for each cell for each case type then is calculated. This is the basis for the standard rate. In this study, the standard was the national Medicare average. To calculate the standard rate, the number of observations in the numerator file for each age/sex bucket is counted and divided by the corresponding count of population (denominator). This yields the standard age/sex specific rate.

These age/sex specific rates are then applied in each population area for each case type. This is done by multiplying the standard age/sex specific rate by the age/sex specific population to obtain an age/sex specific expected number of admissions within each cell. These are aggregated to give an age/sex-adjusted expected number of admissions for the area/case type combination.

From this expected number, an observed to expected ratio (O/E) is developed. The O/E ratio for each case type in each population area is multiplied by the standard rate to yield the age/sex adjusted rate.

#### Standardization

All per capita rate data contained in the analysis are adjusted for the age and sex structure of the local population relative to the national Medicare average, which is used as the standard. The calculation of national rates for utilization used data from all 50 states and the District of Columbia.

The calculation of statewide rates for utilization uses data only for that state's residents and excludes from the calculation the neighboring states' portion of any cross-state population area.

#### Chi Square Test

A Chi Square Test is used to measure significance in the degree to which an observed number of events differs from an expected number because it is both a simple and a conservative test for evaluating whether deviations from expected are likely to result from chance variation alone. It is also commonly used by epidemiologists for similar applications.

The formula for Chi Square is:  $\frac{[O-E]^2}{E}$

where O is the count of observed discharges and E is the number of events expected given the state average after adjustment for the area's age/sex composition. The level of statistical significance -- .05, .01, or .001 -- of the resulting number in a Chi Square Distribution Table, a standard feature of most statistics textbooks. The Chi Square test is applied only to the admissions "event."

### Systematic Component of Variation (SCV)

The SCV calculation uses the same data elements as the Chi Square described above, except that a calculation is made across all areas for each case type using a random variable determined as  $[O-E] - E$ . It is a relative measure of difference between observed and expected admissions. Using this random variable, the systematic variation between areas for each case type can be determined independent of the difference in the number of cases in the category.<sup>1</sup> The formula is:

$$SCV = 1000 * (1/k) [Y_i - (1/E_i)] \text{ where}$$

$$Y_i = \ln [(O_i + 0.5)/(E_i + 0.5)] = [O_i - E_i]/E_i$$

If any  $E_i = 0$ , then that term in the summation is assigned a value of 0

A doubling of the SCV represents a significant difference in variation for a given case type.

### Coefficient of Variation

The coefficient of variation (CV) is the standard deviation of the sample divided by the mean, another measure of relative variation in admission rates for a given case type between population areas. If the CV is large for a particular case type, then observed to expected (O/E) admission ratios across areas for that condition or procedure are likely to exhibit considerable variation. Causes of hospitalization with small CVs have O/E admission ratios more closely grouped about one (1.00), in a relative sense, when compared to those with large CVs.

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1. Klim McPherson, et.al, "Small Area Variations in the use of common surgical procedures: an international comparison of New England, England and Norway, New England Journal of Medicine, 307: 1310-1314, November 18, 1982.

TECHNICAL APPENDIX: Part IV: DRG Components of Case Types Used in this Analysis  
(pediatric, maternity-related, newborn and neonate DRGs are all excluded)

Total Admissions  
Total Medical  
Total Surgical

All DRGs  
All medical DRGs  
All surgical DRGs

Modified DRG (mDRG)

DRG COMPONENTS

Medical-Local (local hospital focus)

degen nerv sys disorder	12
trans ischemic attack#	15
concussion	31-33
eye disorders	43-48
other ENT diagnoses	64-67, 71-74
adult otitis media	68,69
pulmonary embolism	78
respiratory infection & inflammation	79-81
other respiratory diagnoses	83-85, 92-95, 101, 102
pleural effusion	85-86
pulmonary edema & resp failure	87
chronic obstructive lung disease	88
adult pneumonia#	89, 90
bronchitis and asthma#	96, 97
respiratory signs/symptoms	99, 100
heart failure and shock#	127, 129
deep vein thrombophlebitis	128
atherosclerosis	132, 133
hypertension	134
cardiac arrhythmia#	138, 139
angina pectoris#	140
syncope & collapse	141, 142
chest pain	143
other digestive disease	146, 147, 150-153, 159, 160, 168-171
peptic ulcer	176-177
adult gastro-enteritis#	182, 183
dental & oral dis	185, 186
other hepatobiliary	202-205
pancreas disorders	204
fracture femur/hip/pelvis	235-237
connective tissue dis	240, 241
medical back	243
other fractures/sprains	250-255
skin ulcers	271
other skin & tissue disorders	271-276, 280-284
cellulitis	277-279
nutritional & misc metabolic disorders#	296-298
kidney & urinary tract infections	320-322
urinary tract stones	323-324
male repro sys dis	346-350, 352
malig female repro dis	366-369
other blood disorders	392-394, 397-399
red blood cell disorders	395, 396
acute adjustment reaction	425
depressive neurosis	426
poisoning/toxic effects	439-455
other injuries/pois/tox	444-448, 454, 455
other factors infl'g health	461-467

Medical-Mixed (referral depends on severity)

other nervous sys dis	9-13, 16-22, 34-35
nervous sys neoplasms	10, 11
stupor & coma	23, 27-30
seizures & headache	24, 25, 26
respiratory neoplasms	82
interstitial lung disease	92-93
circulatory disorder w. cardiac cath	124-126
peripheral vasc dis	130, 131
other circulatory dis	135-137, 144, 145
digestive malignancy	172, 173
GI obstruction	180, 181
malig hepatobiliary	203
other musculoskel dis	238, 240-242, 244-249, 256
path fractures	239
diabetes	294, 295
other endocrin diagnoses	299-301
kidney & urinary tract diagnoses	318, 319, 325-333
myeloprolif disorder	400-414, 473
infectious disease	415, 418-423
septicemia	416, 417
other mental	424, 427-429, 431, 432
psychoses	430
substance use	433-438
complications of treatment	452-453

Surgical - Local

Stomach, esoph, duo ops	154-156
anal & stomal ops	157, 158
appendectomy	164-167
hepatobiliary sys procedures	191-194, 199-201
major joint operations	209, 471
lower extremity ops	218, 219
soft tissue ops	226, 227
prostatectomy	306, 307
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# Among ten most frequent non-surgical causes of admissions and together accounting for 33 % of all hospital admissions among Medicare >64 in 1986.

\* See John E. Wennberg, "Dealing with Medical Practice Variations: A Proposal for Action" Health Affairs, 1984;3(2):6-32.

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